		EAST		
		12/26/03		
-	283	nut near4 caulk\$4	USPAT;	77
		J / (	US-PGPUB;	
		. / (	EPO; JPO; DERWENT	-
İ_	827	b60g015/06.ipc. or <b>f16</b> f009/54.ipc.	JPO	
-	60	(b60g015/06.ipc. of f16f009/54.ipc. ) and nut	JPO	
<b>!</b> -	103	(280/124.155.ccls. or 280/124.147.ccls.) and nut	USPAT;	1:
			US-PGPUB	
-	13	(280/124.155.ccls. or 280/124.147.ccls.) and nut same weld\$4	USPAT;	1:
	3	(280/124.155.ccls. or 280/124.147.ccls.) and nut same (caulk\$5	US-PGPUB USPAT;	.
-		or captive or encapsulat\$ or deform\$5)	US-PGPUB	•
-	139	267/\$.ccls. and nut same (caulk\$5 or captive or encapsulat\$ or	USPAT;	:
		deform\$5)	US-PGPUB	
-	0	("transverse-mounted") adj engine same transmission same	USPAT;	:
1	0	transmission adj mount same vibration adj damping transverse adj mounted adj engine same transmission same	US-PGPUB	
-	U	transmission adj mount same vibration adj damping	USPAT; US-PGPUB	1.
1.	О	(transverse adj mounted adj engine) same vibration adj	USPAT;	1
[		damp\$4	US-PGPUB	1
-	1	( transverse adj mounted adj engine ) same vibration same	USPAT;	
		damp\$4	US-PGPUB	
-	50	transverse adj mounted adj engine	USPAT; US-PGPUB	
_	0	transvers\$5 adj mounted adj engine same transmission same	USPAT:	
		transmission adj mount same vibration adj damping	US-PGPUB	
-	2	transvers\$5 adj mounted adj engine same mount same	USPAT;	
		vibration adj damp\$4	US-PGPUB	
-	1	("6530587").PN.	USPAT;	
<u>-</u>	0	6530587.URPN.	US-PGPUB USPAT	!
-	11	("0191536"   "1898721"   "2471135"   "3181641"   "3197190"	USPAT	
		"3806151"   "4313618"   "4458918"   "4779894"   "4854606"		
		"6189904").PN.		
-	1	6616159.pn.	USPAT;	:
	4328	lawson.in. or deadrick.in.	US-PGPUB USPAT;	
_	4320	lawson.in. of deadlick.in.	US-PGPUB;	
		·	EPO; JPO;	
			DERWENT	
-	2371	visteon.asn.	USPAT;	
	,	·	US-PGPUB;	
			EPO; JPO; DERWENT	
_	22	(lawson.in. or deadrick.in.) and visteon.asn.	USPAT;	1:
			US-PGPUB;	
			EPO; JPO;	
	25000	B20C044/42 inc. or B20C04E/44 inc. E40E004/200 inc.	DERWENT	
-	25002	B29C044/12.ipc. or B29C045/14.ipc. F16F001/368.ipc.	USPAT; US-PGPUB;	2
			EPO; JPO;	.
			DERWENT;	
		·	IBM_TDB	
-	54	(B29C044/12.ipc. or B29C045/14.ipc. F16F001/368.ipc.) and leaf	USPAT;	20
		adj spring	US-PGPUB;	
			EPO; JPO; DERWENT;	
			IBM_TDB	
-	11091	B29C039/10.ipc. or B60G011/08.ipc. or F16F001/18.ipc.	USPAT;	2
			US-PGPUB;	
			EPO; JPO;	
			DERWENT;	
	731	( B29C039/10.ipc. or B60G011/08.ipc. or F16F001/18.ipc. ) and	IBM_TDB USPAT;	2
	/31	leaf adj spring	US-PGPUB;	-
			EPO; JPO;	
			DERWENT;	
L	L		IBM_TDB	

L Number	Hits	Search Text	DB	Т
3	2	(method.clm. or process.clm.) adj5 (leaf.clm. adj2 spring.clm.)	USPAT;	†
	_	and bladder	US-PGPUB	1
5	676	(method or process) adj5 (leaf adj2 spring)	USPAT;	
			US-PGPUB;	į
		,	EPO; JPO;	1
		·	DERWENT;	
			IBM_TDB	
6	676	(method or process) adj5 (leaf adj2 spring)	USPAT;	
			US-PGPUB;	
			EPO; JPO;	
			DERWENT;	
			IBM_TDB	
7	676	(method or process) adj5 (leaf adj2 spring)	USPAT;	
			US-PGPUB;	
			EPO; JPO;	
			DERWENT;	ļ
_	_		IBM_TDB	
8	1	(method.clm. or process.clm.) adj5 (leaf.clm. adj2 spring.clm.)	USPAT;	
		same transverse.clm. adj leaf.clm.	US-PGPUB	ļ
4	114	(method.clm. or process.clm.) adj5 (leaf.clm. adj2 spring.clm.)	USPAT;	
			US-PGPUB	
9	80	(method or process) adj5 (leaf adj2 spring) same form	USPAT;	
			US-PGPUB;	
	.		EPO; JPO;	
			DERWENT;	į
40	00	(modbod on mooooo) mdif (loof adiO oo in n)	IBM_TDB	
10	60	(method or process) adj5 (leaf adj2 spring) same mold\$4 .	USPAT;	•
			US-PGPUB;	
			EPO; JPO;	
			DERWENT;	
11	12	(US-6660114-\$ or US-6461455-\$ or US-6422540-\$ or	IBM_TDB USPAT;	
''	12	US-6361032-\$ or US-5043117-\$ or US-4894108-\$ or	US-PGPUB	
		US-4747898-\$ or US-4707317-\$ or US-4659071-\$ or	03-1-01-01	
	•	US-4420450-\$).did. or (US-20020096249-\$ or	ļ.	
~		US-20020153689-\$).did.		
12	18	(method or process) adj5 (leaf adj2 spring) same mold\$4 same	USPAT;	
		cur\$4	US-PGPUB;	i
			EPO; JPO;	
			DERWENT;	
		_	IBM_TDB	
13	10	(method or process) adj5 (leaf adj2 spring) same mold\$4 same	USPAT;	
		cur\$4 same (fiber\$6 or fibre\$5)	US-PGPUB;	
			EPO; JPO;	
			DERWENT;	
		land a la	IBM_TDB	:
14	27	(method or process) adj5 (leaf adj2 spring) same (fiber\$6 or	USPAT;	2
		fibre\$5) same resin\$6	US-PGPUB;	
			EPO; JPO;	
]			DERWENT;	
15	4	(mothed or process) adif (loof adia and a loof)	IBM_TDB	01
15	1	(method or process) adj5 (leaf adj2 spring) same (fiber\$6 or fibre\$5) same resin\$6 same (hollow or tub\$6)	USPAT;	20
		incepo) same resinpo same (nollow or tubpo)	US-PGPUB;	
			EPO; JPO; DERWENT;	1
			IBM_TDB	1
16	1	   1992-142610.NRAN.	DERWENT	2
17	343	(leaf adj2 spring) same (fiber\$6 or fibre\$5) same resin\$6	USPAT;	2
••	343	(1000) 2011 obinity) camo (indentity of indexts) same resiliate	US-PGPUB:	1
			EPO; JPO;	1
			DERWENT;	1
,			IBM TDB	1
18	139	(leaf adj2 spring) same (fibers! or fibres!) same resin\$6	USPAT;	2
•		( ) and a principle of the state of the stat	US-PGPUB;	-
			EPO; JPO;	1
		1		1
			DERWENT;	1

19	3479	267/36.1-52.ccls. or 267/148-149.ccls.	USPAT;
20	124	(267/36.1-52.ccls. or 267/148-149.ccls.) and resin\$6 same fib\$5	US-PGPUB
20	124	(207/30.1-32.00is. of 207/146-149.00is.) and resinso same hips	USPAT;
21	0	6460838.URPN.	USPAT
. 22	7	["4530490"   "4556204"   "4565356"   "4659071"   "4696459"	USPAT
23	8	"4707317"   "4969633").PN.   (267/36.1-52.ccls. or 267/148-149.ccls.) and resin\$6 same fib\$5	LICDAT.
23	0	same taper\$4	USPAT; US-PGPUB
24	11	resin\$6 same fib\$5 same taper\$4 same leaf adj2 spring	USPAT;
			US-PGPUB
26	64	(resin\$6 same fib\$5 same leaf adj2 spring) not ( (leaf adj2 spring) same (fibers! or fibres!) same resin\$6)	USPAT;
27	73	((leaf adj2 spring) same (fibers! or fibres!) same resin\$6) not	US-PGPUB USPAT;
		( resin\$6 same fib\$5 same leaf adj2 spring)	US-PGPUB:
			EPO; JPO;
İ			DERWENT;
25	130	resin\$6 same fib\$5 same leaf adj2 spring	IBM_TDB USPAT;
			US-PGPUB
28	11	(leaf adj2 spring) same (fibers! or fibres!) same resin\$6 same	USPAT;
		(hollow or tub\$6)	US-PGPUB: EPO: JPO:
1			DERWENT;
00			IBM_TDB
29	41	EBATA.in. and SAITO.in.	USPAT;
		SAITO.III.	US-PGPUB; EPO; JPO;
			DERWENT;
30	14	EDATA in and	IBM_TDB
30	14	EBATA.in. and SAITO.in. and leaf adj spring	USPAT; US-PGPUB;
		or and and took day opining	EPO; JPO;
			DERWENT;
31	2	EBATA.in, and	IBM_TDB USPAT;
	_	SAITO.in. and leaf adj spring same hollow	US-PGPUB;
			EPO; JPO;
	!		DERWENT; IBM TDB
32	. 7	( (leaf adj2 spring) same (fibers! or fibres!) same resin\$6 ) not	USPAT;
		( resin\$6 same fib\$5 same leaf adj2 spring) and mold\$4	US-PGPUB;
			EPO; JPO;
			DERWENT; IBM_TDB
33	32	(leaf adj2 spring) same (fibers! or fibres!) same resin\$6 same	USPAT;
		mold\$4	US-PGPUB;
		·	EPO; JPO; DERWENT;
			IBM_TDB
34 .	9	(leaf adj2 spring) same (fibers! or fibres!) same resin\$6 same mold\$4 and (longitud\$6 or elongated) near4 (fibers! or fibres!)	USPAT;
	·	mold\$4 and (longitud\$6 or elongated) near4 (fibers! or fibres!)	US-PGPUB; EPO; JPO;
			DERWENT;
25	0.5		IBM_TDB
35	25	(leaf adj2 spring) same (fibers! or fibres!) same resin\$6 same (longitud\$6 or elongated) near4 (fibers! or fibres!)	USPAT;
		(longitude of elongated) flear4 (libers: of libres:)	US-PGPUB; EPO; JPO;
			DERWENT;
36	1	2000-273563.NRAN.	IBM_TDB
37	1	2000-273303.NRAN. 1983-A1111K.NRAN.	DERWENT DERWENT
38	1	1982-83998E.NRAN.	DERWENT
39	10	(US-5425829-\$ or US-5118373-\$ or US-5098510-\$ or	USPAT; JPC
		US-4969633-\$ or US-4565356-\$ or US-4530490-\$ or US-6189904-\$ or US-4546958-\$).did. or (JP-55086935-\$ or	
		JP-60116933-\$).did.	

		1	
-	10	kawada.in. and tadano.in.	USPAT;
			US-PGPUE
	}		EPO; JPO;
1_	4	(("5088704") or ("5064176") or ("5040775") or ("5024461")).PN.	DERWENT
	7	(( 5000704 ) 01 ( 5004170 ) 01 ( 5040775 ) 01 ( 5024461 )).PN.	USPAT;
-	11	(("5263694") or ("4425065") or ("3878598") or ("3845860") or	US-PGPUE USPAT;
		("3809139") or ("3736969") or ("2722259") or ("2649884") or	US-PGPUE
		("2138409") or ("1759339") or ("1705463")).PN.	
-	15	1 ( = = = = = ;	USPAT
		US-5024461-\$ or US-5263694-\$ or US-4425065-\$ or	
		US-3878598 <sup>1</sup> \$ or US-3845860-\$ or US-3809139-\$ or US-3736969-\$ or US-2722259-\$ or US-2649884-\$ or	
		US-2138409-\$ or US-1759339-\$ or US-1705463-\$).did.	
-	0	("0036198").PN.	JPO
-	0	( g	JPO
-	788		JPO .
-	274	280/124.155.ccls. or 280/124.147.ccls.	USPAT;
			US-PGPUB
ļ			EPO; JPO; DERWENT
-	106	(280/124.155.ccls. or 280/124.147.ccls.) and nut	USPAT;
			US-PGPUB
			EPO; JPO;
	168	(200/424 455  200/404 447 -	DERWENT
-	168	(280/124.155.ccls. or 280/124.147.ccls.) not ((280/124.155.ccls. or 280/124.147.ccls.) and nut)	USPAT;
		or 2007 124. 147.0018.) and flut)	US-PGPUB EPO; JPO;
			DERWENT
-	1	6412798.URPN.	USPAT
•	11	("4274655"   "RE31184"   "4462608"   "4497523"   "4531759"	USPAT
		"4618127"   "4721325"   "5064176"   "5211380"   "5308104"	
_	2717	"5454585").PN. ikoma.in.	LICDAT
		inorna.iii.	USPAT; US-PGPUB
			EPO; JPO;
			DERWENT
-	49	ikoma.in. and kayaba.asn.	USPAT;
			US-PGPUB
			EPO; JPO; DERWENT
•	6340	yoshiyuki.in.	USPAT:
		·	US-PGPUB
•	17	yoshiyuki.in. and kodama.in.	USPAT;
_	18	(irie.in. or yoshiyuki.in.) and (yosie.in. or kodama.in.)	US-PGPUB
	10	(ine.iii. or yoshiyuki.iii.) and (yosie.iii. or kodama.iii.)	USPAT;
-	141	(irie.in. or yoshiyuki.in.) and (hayashi.in. or tsuneo.in.)	US-PGPUB USPAT;
			US-PGPUB
-	4	((irie.in. or yoshiyuki.in.) and (hayashi.in. or tsuneo.in.)) and	USPAT;
		(akio.in. or morioka.in.)	US-PGPUB
•	57	188/321.11.ccls. and nut	USPAT;
			US-PGPUB: EPO: JPO:
			DERWENT
•	158	267/220-221,292-294.ccls. and nut same (rubber or elastom\$6)	USPAT;
		·	US-PGPUB;
		`·	EPO; JPO;
-	333	267/220-221,292-294.ccls. and nut	DERWENT
			USPAT; US-PGPUB;
	]	.	EPO; JPO;
			DERWENT
-	137	((267/141.4) or (267/141.5)).CCLS.	USPAT;
	1		US-PGPUB

ŕ

-	27	267/220-221,292-294.ccls. and nut same groove\$4	USPAT;
	ļ		US-PGPUB
			EPO; JPO;
	·		DERWENT
-	0	267/220-221,292-294.ccls. and nut same captive	USPAT;
	[	<i>;</i>	US-PGPUB
			EPO; JPO;
		007/000 004 000 004	DERWENT
-	2	267/220-221,292-294.ccls. and nut same caulk\$4	USPAT;
			US-PGPUB
		/	EPO; JPO;
_	132	267/220-221,292-294.ccls. and nut same (plate or piece)	DERWENT
	132	2011220-221,232-234.ccis. and flut same (plate of piece)	USPAT; US-PGPUB
İ			EPO; JPO;
			DERWENT
-	233	saenz.in.	USPAT:
	]	·	US-PGPUB
			EPO; JPO;
			DERWENT
-	3	saenz.in. and cano.in.	USPAT;
·			US-PGPUB
			EPO; JPO;
		0000 555700 NDAN	DERWENT
-	1	2003-555702.NRAN.	DERWENT
-	346	(267/221).CCLS.	USPAT;
	12	kawada.in. and tadano.in.	US-PGPUB
-	12	Rawaua.iii. aiiu tauaiiu.iii.	USPAT; US-PGPUB
		·	EPO; JPO;
			DERWENT
-	283	nut near# caulk\$4	USPAT:
			US-PGPUB:
		f	EPO; JPO;
		1.00 0.500	DERWENT
-	827	b60g015/06.ipc. or f16f009/54.jpc.	JPO
_	103	(b60g015/06.ipc. or f16f009/54.ipc. ) and nut (280/124.155.ccls. or 280/124.147.ccls.) and nut	JPO
	103	(200/124.133.ccis. 01 200/124.147.ccis.) and nut	USPAT;
_	13	(280/124.155.ccls. or 280/124.147.ccls.) and nut same weld\$4	US-PGPUB USPAT;
		(2007) 127.100.0010. 01 200724.147.0013.) and that same weldight	US-PGPUB
-	3	(280/124.155.ccls. or 2\$0/124.147.ccls.) and nut same (caulk\$5	USPAT:
		or captive or encapsulat\$ or deform\$5)	US-PGPUB
i -	139	267/\$.ccls. and nut same (caulk\$5 or captive or encapsulat\$ or	USPAT;
		deform\$5)	US-PGPUB
-	0	("transverse-mounted") adj engine same transmission same	USPAT;
Ì		transmission adj mount same vibration adj damping	US-PGPUB
-	0	transverse adj mounted adj engine same transmission same	USPAT;
	0	transmission adj mount same vibration adj damping	US-PGPUB
] -		(transverse adj mounted adj engine) same vibration adj	USPAT;
_	1	( transverse adj mounted adj engine ) same vibration same	US-PGPUB USPAT;
	'	damp\$4	US-PGPUB
-	50	transverse adj mounted adj engine	USPAT;
		and the second s	US-PGPUB
-	0	transvers\$5 adj mounted adj engine same transmission same	USPAT;
		transmission adj mount same vibration adj damping	US-PGPUB
-	2	transvers\$5 adj mounted adj engine same mount same	USPAT;
1		vibration adj damp\$4	US-PGPUB
-	1	("6530587") <b>/</b> PN.	USPAT;
]	] [	6520597 LIDDN	US-PGPUB
-	0	6530587.URPN.	USPAT
1	''	("0191536 <mark>f"   "1898721"   "2471135"   "3181641"   "3197190"  </mark>   "3806151 <b>f"   "4</b> 313618"   "4458918"   "4779894"   "4854606"	USPAT
		"6189904").PN.	
-	1	6616159.pn.	USPAT;
		- <del> </del>	US-PGPUB

	1 4555		
-	4328	lawson.in. or deadrick.in.	USPAT;
			US-PGPUE
			EPO; JPO;
	2371	visteon.asn.	DERWENT
_	23/1	violeoff.aoff.	USPAT;
			US-PGPUE
			EPO; JPO;
<u>-</u>	22	(lawson.in. or deadrick.in.) and visteon.asn.	DERWENT
		(lawson.iii. or deadrick.iii.) and visicott.asii.	USPAT; US-PGPUE
			EPO; JPO;
į			DERWENT
-	25002	B29C044/12.ipc. or B29C045/14.ipc. F16F001/368.ipc.	USPAT;
		======================================	US-PGPUE
	l		EPO; JPO;
			DERWENT
			IBM TDB
- ·	54	(B29C044/12.ipc. or B29C045/14.ipc. F16F001/368.ipc.) and leaf	USPAT;
		adj spring	US-PGPUB
			EPO; JPO;
		'	DERWENT
			IBM_TDB
-	11091	B29C039/10.ipc. or B60G011/08.ipc. or F16F001/18.ipc.	USPAT;
		•	US-PGPUB
			EPO; JPO;
			DERWENT
	731	/ P20C020/40 inc. on PC0C044/00 inc. of F40E004/40 inc.	IBM_TDB
-	/31	( B29C039/10.ipc. or B60G011/08.ipc. or F16F001/18.ipc. ) and leaf adj spring	USPAT;
ŀ		lear adj spring	US-PGPUB
			EPO; JPO;
			DERWENT
-	43	( B29C039/10.ipc. or B60G011/08.ipc. or F16F001/18.ipc. ) and	IBM_TDB USPAT;
		leaf adj spring same mold\$4	US-PGPUB
		, rear any opining carries more pro-	EPO; JPO;
			DERWENT:
1			IBM TDB
	1	2003-228100.NRAN.	DERWENT
-	40415	B29C039/10.ipc. B29C044/12.ipc. B29C045/14.ipc.	USPAT;
		B29C070/42.ipc.	US-PGPUB
		B29C070/44.ipc. B29K105:08.ipc. B29L031/30.ipc.	EPO; JPO;
		B60G011/02.ipc. B60G011/08.ipc.	DERWENT;
 	000	F16F001/18.ipc. F16F001/368.ipc.	IBM_TDB
1-	988	(B29C039/10.ipc. B29C044/12.ipc. B29C045/14.ipc. B29C070/42.ipc.	USPAT;
		B29C070/44.ipc. B29K105:08.ipc. B29L031/30.ipc.	US-PGPUB
!		B60G011/02.ipc. B60G011/08.ipc.	EPO; JPO;
		F16F001/18.ipc. F16F001/368.ipc. ) and leaf adj spring	DERWENT; IBM_TDB
-	8	(B29C039/10.ipc. B29C044/12.ipc. B29C045/14.ipc.	USPAT;
		B29C070/42.ipc.	US-PGPUB
		B29C070/44.ipc. B29K105:08.ipc. B29L031/30.ipc.	EPO; JPO;
		B60G011/02.ipc. B60G011/08.ipc.	DERWENT:
		F16F001/18.ipc. F16F001/368.ipc. ) and leaf adj spring same	IBM_TDB
	į	(fiberglas or fibreglas or fiberglass or fibreglass) same resin\$5	<del></del>
- ·	10	(US-6616159-\$ or US-6460838-\$ or US-6361032-\$ or	USPAT;
		US-4969633-\$ or US-4786033-\$ or US-4659071-\$).did. or	US-PGPUB
		(US-20030122293-\$ or US-20020153648-\$).did. or	EPO
. ,		(GB-2375502-\$ or DE-10211582-\$ or JP-2003039453-\$).did.	_
-	8	(B29C039/10.ipc. B29C044/12.ipc. B29C045/14.ipc.	USPAT;
		B29C070/42.ipc. B29C070/44.ipc. B29C405.08.ipc. B29C024/20.ipc	US-PGPUB;
1		B29C070/44.ipc. B29K105:08.ipc. B29L031/30.ipc. B60G011/02.ipc. B60G011/08.ipc.	EPO; JPO;
		F16F001/18.ipc. F16F001/368.ipc. ) and leaf adj spring same	DERWENT;
		(fiberglas or fibreglas or fiberglass or fibreglass) same resin\$5	IBM_TDB
		(historians or instegras or instegrass) same resinas	

-	2	"20020153648"	USPAT;
			US-PGP
		·	EPO; JP
			DERWE
			IBM_TDI
-	213	transverse adj leaf adj spring	USPAT;
1			US-PGP
			EPO; JP
			DERWE
	64	(transverse adj leaf adj spring) and (method or process)	USPAT;
			US-PGP
		·	EPO; JP
			DERWE
-	17	(transverse adj leaf adj spring) and (method.clm. or process.clm.)	USPAT;
İ			US-PGP
			EPO; JP
		·	DERWE
-	114	(method.clm. or process.clm.) adj5 (leaf.clm. adj2 spring.clm.)	USPAT;
			US-PGP
-	2	(method.clm. or process.clm.) adj5 (leaf.clm. adj2 spring.clm.)	USPAT;
L		and inflatable same bladder	US-PGP

Comparison of the comparison	L Number	Hits	Search Text	DB
5         676         (method or process) adj5 (leaf adj2 spring)         US-PGFL USPAT: US-PGFL EPO: JPC DERWEN IBM TDB USPAT: US-PGFL EPO: JPC DERWEN IBM TDB USPAT: US-PGFL EPO: JPC DERWEN IBM TDB USPAT: US-PGFL EPO: JPC DERWEN IBM TDB USPAT: US-PGFL EPO: JPC DERWEN IBM TDB USPAT: US-PGFL EPO: JPC DERWEN IBM TDB USPAT: US-PGFL EPO: JPC DERWEN IBM TDB USPAT: US-PGFL EPO: JPC DERWEN IBM TDB USPAT: US-PGFL EPO: JPC DERWEN IBM TDB USPAT: US-PGFL US-ATABBAS (method cin. or process.cim. adj leaf.cim. adj2 spring.cim.)         USPAT: US-PGFL EPO: JPC DERWEN IBM TDB USPAT: US-PGFL US-PGFL US-PGFL EPO: JPC DERWEN IBM TDB USPAT: US-PGFL EPO: JPC DERWEN IBM TDB US-PGFL US-PGFL EPO: JPC DERWEN IBM TDB US-PGFL US-PGFL EPO: JPC DERWEN IBM TDB US-PGFL US-PGFL EPO: JPC DERWEN IBM TDB US-PGFL US-PGFL EPO: JPC DERWEN IBM TDB US-PGFL US-PGFL EPO: JPC DERWEN IBM TDB US-PGF				
Section	Ŭ	_		
6 676 (method or process) adj5 (leaf adj2 spring)  7 676 (method or process) adj5 (leaf adj2 spring)  8 1 (method.cim. or process.cim.) adj5 (leaf.cim. adj2 spring.cim.) US-PGRI EPO. JPC DERWEN IBM. TDB USPAT. US-PGRI EPO. JPC DERWEN IBM. TDB USPAT. US-PGRI EPO. JPC DERWEN IBM. TDB USPAT. US-PGRI EPO. JPC DERWEN IBM. TDB USPAT. US-PGRI EPO. JPC DERWEN IBM. TDB USPAT. US-PGRI US-PAT.	5	676		
EPO, JPC   DERWEN   IBM TDB   SPAT; US-PGPL   DERWEN   IBM TDB			(member of process) days (lear days opring)	1 '
6 676 (method or process) adj5 (leaf adj2 spring)  7 676 (method or process) adj5 (leaf adj2 spring)  8 1 (method.clm. or process.clm.) adj5 (leaf.clm. adj2 spring.clm.) uSPAT; uS-PGPL EPO; JPC DERWEN IBM. TDB USPAT; uS-PGPL IBM. TDB USPAT; uS-PGPL IBM. TDB USPAT; uS-PGPL IBM. TDB USPAT; uS-PGPL IBM. TDB USPAT; uS-PGPL IBM. TDB USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL US-PGP			,	
6 6 676 (method or process) adj5 (leaf adj2 spring)  7 676 (method or process) adj5 (leaf adj2 spring)  8 1 (method.clm. or process.clm.) adj5 (leaf.clm. adj2 spring.clm.) USPAT: USPCPL EPO, JPC DERWEN BIM TDB USPAT: USPCPL EPO, JPC DERWEN BIM TDB USPAT: USPCPL USPAT:				
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7 676 (method or process) adj5 (leaf adj2 spring)  8 1 (method.clm, or process.clm.) adj5 (leaf.clm. adj2 spring.clm.) USPAT; USPC9P, JPC DERWEN, Same transverse.clm. adj leaf.clm. 4 114 (method.clm, or process.clm.) adj5 (leaf.clm. adj2 spring.clm.) USPAT; USPC9P, JPC DERWEN, Same transverse.clm. adj leaf.clm. adj2 spring.clm.) USPAT; USPC9P, USPAT; USPAT; USPC9P, USPAT; USPC9P, USPAT; USPC9P, USPAT; USPAT; USPC9P, USPAT; USPAT; USPC9P, USPAT; USPAT; USPC9P, USPAT; USPAT; USPAT; USPC9P, USPAT; USPAT; USPC9P, USPAT; USPAT; USPC9P, USPAT; USPAT; USPC9P, USPAT; USPAT; USPC9P, USPAT; USPC9P, USPAT; USPC9P, USPAT; USPC9P, USPAT; USPC9P, USPAT; USPC9P, USPAT; USPC9P, USPAT; USPC9P, USPAT; USPC9P, USPAT; USPC9P, USPAT; USPC9P, USPAT; USPC9P, USPAT; USPC9P, USPAT; USPC9P, USPAT; USPC9P, USPC	6	676	(method or process) adi5 (leaf adi2 spring)	
7 676 (method or process) adj5 (leaf adj2 spring)  8 1 (method.clm. or process.clm.) adj5 (leaf.clm. adj2 spring.clm.) USPAT; USPGPL EPO, JPC (method.clm. or process.clm.) adj5 (leaf.clm. adj2 spring.clm.) uSPAT; USPAT;			(	1
7 676 (method or process) adj5 (leaf adj2 spring)  8 1 (method.cim. or process.cim.) adj5 (leaf.cim. adj2 spring.cim.) uS-PGPL EPC, JPC DERWER Same transverse.cim. adj leaf.cim. adj2 spring.cim.) uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL USPAT; uS-PGPL US-A1032-\$ or US-6461455-\$ or US-6422540-\$ or uS-6361032-\$ or US-5043117-\$ or uS-64894108-\$ or uS-PGPL US-A1747898-\$ or uS-420450-\$), adi. dewarda.in. and tadano.in.  10 4 (("5088704") or ("5064176") or ("5040775") or ("5024461")).PN. uSPAT; uS-PGPL US-PGPL				
BIM TDB			, ,	
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8 1 (method.cim. or process.cim.) adj5 (leaf.cim. adj2 spring.cim.) USPAT; USPAT; USPAT; USPC). Pic (method.cim. or process.cim.) adj5 (leaf.cim. adj2 spring.cim.) USPAT; USPAT; USPC). Pic (method or process) adj5 (leaf adj2 spring) same form USPAT; USPC). Pic (DERWEN IBM TDB U	7	676	(method or process) adj5 (leaf adj2 spring)	_
8 1 (method.clm. or process.clm.) adj5 (leaf.clm. adj2 spring.clm.)				US-PGPL
BBM_TDB				
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4       114       same transverse.clm. adj leaf.clm.       US-PGPL USPAT: US-PGPL USPAT: US-PGPL USPAT: US-PGPL USPAT: US-PGPL USPAT: US-PGPL USPAT: US-PGPL USPAT: US-PGPL USPAT: US-PGPL USPAT: US-PGPL USPAT: US-PGPL USPAT: US-PGPL USPAT: US-PGPL US-PGPL EPG: JPC DERWER. IBM_TDB USPAT: US-PGPL EPG: JPC DERWER. IBM_TDB USPAT: US-PGPL EPG: JPC DERWER. IBM_TDB US-6361032-\$ or US-6461455-\$ or US-6422540-\$ or US-6361032-\$ or US-6461455-\$ or US-645971-\$ or US-6361032-\$ or US-6707317-\$ or US-4894108-\$ or US-A77898-\$ or US-3093117-\$ or US-4894108-\$ or US-A77898-\$ or US-20020153689-\$).did. (US-20020096249-\$ or US-20020153689-\$).did. (US-20020096249-\$ or US-20020153689-\$).did. ("5263694") or ("504461").PN.       USPAT: US-PGPL EPG: JPC DERWER. USPAT: US-PGPL EPG: JPC DERWER. USPAT: US-PGPL USPAT: US-PGPL USPAT: US-PGPL EPG: JPC DERWER. US-5034461-\$ or US-5064176-\$ or US-5044673").PN.       USPAT: US-PGPL USPAT: US-PGPL USPAT: US-PGPL USPAT: US-PGPL US-5024461-\$ or US-5064176-\$ or US-5064775-\$ or US-5084704-\$ or US-5064775-\$ or US-3736989-\$ or US-3845860-\$ or US-3809139-\$ or US-3736989-\$ or US-3845860-\$ or US-3809139-\$ or US-3736989-\$ or US-3845860-\$ or US-3609139-\$ or US-264461-\$ or US-264461-\$ or US-264461-\$ or US-2649884-\$ or US-2738499-\$ or US-2722259-\$	8	1	(method.clm. or process.clm.) adj5 (leaf.clm. adj2 spring.clm.)	
114				
9 80 (method or process) adj5 (leaf adj2 spring) same form US-PGPL USPAT; USPGPL EPO; JPC DERWEIN IBM, TDB USPAT; US-6361032-\$ or US-6461455-\$ or US-6422540-\$ or US-670147898-\$ or US-4707317-\$ or US-4894108-\$ or US-PGPL IBM, TDB USPAT; US-968019-\$ or US-4707317-\$ or US-4894108-\$ or US-4707317-\$ or US-4894108-\$ or US-PGPL US-4747898-\$ or US-4707317-\$ or US-4859071-\$ or US-4707317-\$ or US-4859071-\$ or US-20020153689-\$), did. kawada.in. and tadano.in. USPAT; US-PGPL EPO; JPC DERWEIN ISPAT; US-PGPL USPAT; US-PGPL USPAT; US-PGPL US-73736989") or ("3736989") or ("3736989") or ("37369887") or ("37369887") or ("37369887") or ("37369887") or ("37369887") or ("37369887") or ("37369887") or US-3736989-\$ or US-364176-\$ or US-5024461"), PN. US-PGPL US-PGPL US-97378989-\$ or US-5024461-\$ or US-502463"), PN. US-PGPL US-97378989-\$ or US-3898193-\$ or US-3898193-\$ or US-3736989-\$ or US-3809139-\$ or US-5024461-\$ or US-5263694-\$ or US-3809139-\$ or US-7649884-\$ or US-376989-\$ or US-3809139-\$ or US-376989-\$ or US-3809139-\$ or US-376989-\$ or US-3809139-\$ or US-376989-\$ or US-3809139-\$ or US-3809139-\$ or US-376989-\$ or US-3809139-\$ or US-376998-\$ or US-3809139-\$ or US-3809139-\$ or US-376998-\$ or US-3809139-\$	4	114		
9 80 (method or process) adj5 (leaf adj2 spring) same form USPAT; US-PGPL EPO; JPC DERWEN IBM, TDB USPAT; US-6660114-\$ or US-6461455-\$ or US-6422540-\$ or US-9261032-\$ or US-503417-\$ or US-4894108-\$ or US-4777898-\$ or US-4707317-\$ or US-4894108-\$ or US-92020153689-\$).did. or (US-20020096249-\$ or US-20020153689-\$).did. https://doi.or/10.10/2.0002096249-\$ or US-20020153689-\$).did. or (US-20020096249-\$ or US-20020153689-\$).did. or (US-20020096249-\$ or US-20020153689-\$).did. https://doi.or/10.10/2.0002096249-\$ or ("504476") or ("504476") or ("5044775") or ("5024461")).PN. US-PGPL US-PGPL US-PGPL US-PGPL US-PGPL US-PGPL US-PGPL US-PGPL US-PGPL US-PGPL US-PGPL US-PGPL US-PGPL US-903498-\$ or US-304975-\$ or US-304989-\$ or US-5064475-\$ or US-309498-\$ or US-2649884-\$ or US-2649884-\$ or US-2649884-\$ or US-3789898-\$ or US-5064975-\$ or US-3878598-\$ or US-3845860-\$ or US-3809139-\$ or US-378598-\$ or US-3845860-\$ or US-3809139-\$ or US-378598-\$ or US-3845860-\$ or US-3809139-\$ or US-378598-\$ or US-37				
10   60   (method or process) adj5 (leaf adj2 spring)   same mold\$4   US-PGPL   EPO; JPC   DERWEN   IBM TOB   US-PAT; US-PGPL   EPO; JPC   DERWEN   IBM TOB   US-6361032-\$ or US-5043117-\$ or US-4894108-\$ or   US-441747898-\$ or US-4707317-\$ or US-4659071-\$ or   US-PGPL   US-PGPL   US-4707317-\$ or US-4659071-\$ or   US-20020153689-\$).did.	9	80	(method or process) adj5 (leaf adj2 spring) same form	
EPO: JPC   DERWEN			, , , , , , , , , , , , , , , , , , , ,	
DERWEN   IBM_TIDB   USPAT; US-PGPL   US-A660114-\$ or US-6461455-\$ or US-6422540-\$ or US-6361032-\$ or US-5043117-\$ or US-4894108-\$ or US-4747898-\$ or US-5043117-\$ or US-4659071-\$ or US-420450-\$ or US-20020096249-\$ or US-20020153689-\$).did.   Savada.in. and tadano.in.   USPAT; US-PGPL   USPAT; US-9GPL   USPAT; US-PGPL   USPAT;			·	
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US-PGPL   PO; JPC   DERWEN   IBM TDB   US-474747898 * or US-4661455-\$ or US-6422540-\$ or US-6361032-\$ or US-5043117-\$ or US-48594108-\$ or US-A74747898 * or US-4707317-\$ or US-4659071-\$ or US-420450-\$).did. or (US-20020096249-\$ or US-20020153689-\$).did.   US-PGPL				IBM TDB
US-PGPL   EPO; JPC   DERWEN   IBM TDB   US-6361032-\$ or US-6461455-\$ or US-6422540-\$ or US-6361032-\$ or US-5043117-\$ or US-4894108-\$ or US-A777898-\$ or US-4707317-\$ or US-4894108-\$ or US-20020153689-\$).did. or (US-20020096249-\$ or US-20020153689-\$).did.   Line	10	60.	(method or process) adj5 (leaf adj2 spring) same mold\$4	USPAT;
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US-4420450-\$), did. or (US-20020096249-\$ or US-20020153689-\$), did. kawada.in. and tadano.in.  USPAT; US-PGPL EPO; JPC DERWEN  (("5088704") or ("5064176") or ("5040775") or ("5024461")).PN. USPAT; US-PGPL ("5809139") or ("4425065") or ("3878598") or ("3845860") or ("3809139") or ("3736969") or ("2722259") or ("2649884") or ("2138409") or ("1759339") or ("1705463")).PN. US-PGPL US-AT; US-PGPL US-3878598-\$ or US-5024461-\$ or US-5064176-\$ or US-5040775-\$ or US-3878598-\$ or US-5263694-\$ or US-4425065-\$ or US-3736969-\$ or US-3845860-\$ or US-3890193-\$ or US-3736969-\$ or US-2722259-\$ or US-2649884-\$ or US-2138409-\$ or US-1759339-\$ or US-1705463-\$).did. ("0036198").PN. US-QGPL US-2138409-\$ or US-1759339-\$ or US-1705463-\$).did. ("0036198").PN. US-QGPL US-2138409-\$ or US-1759339-\$ or US-1705463-\$).did. US-PGPL US				US-PGPL
US-20020153689-\$).did. kawada.in. and tadano.in.  USPAT; US-PGPL EPO; JPC DERWEN USPAT; US-PGPL USPAT; US-PGPL USPAT; US-PGPL USPAT; US-PGPL USPAT; US-PGPL USPAT; US-PGPL USPAT; US-PGPL USPAT; US-PGPL USPAT; US-PGPL USPAT; US-PGPL USPAT; US-PGPL USPAT; US-PGPL USPAT; US-PGPL USPAT; US-PGPL USPAT; US-PGPL USPAT; US-PGPL USPAT; US-PGPL USPAT; US-PGPL US-345860°) or ("2722259°) or ("2649884") or US-5024461-\$ or US-5064176-\$ or US-5040775-\$ or US-5024461-\$ or US-5263694-\$ or US-3809139-\$ or US-3736969-\$ or US-3845860-\$ or US-3809139-\$ or US-2138409-\$ or US-1759339-\$ or US-2649884-\$ or US-2138409-\$ or US-1759339-\$ or US-2649884-\$ or US-2138409-\$ or US-1759339-\$ or US-2649884-\$ or US-2138409-\$ or US-1759339-\$ or US-1705463-\$).did.  O ("0036198").PN. D (b609015/06.ipc. or f16f009/54.ipc.).CCLS. DPO JPO JPO JPO JPO JPO DERWEN USPAT; US-PGPL EPO; JPC DERWEN USPAT; US-PGPL EPO; JPC DERWEN US-AT; US-PGPL EPO; JPC DERWEN			US-4747898-\$ or US-4707317-\$ or US-4659071-\$ or	
- 10 kawada.in. and tadano.in.    VSPAT; US-PGPL				
- 4 (("5088704") or ("5064176") or ("5040775") or ("5024461")).PN. US-PGPL EPO; JPC DERWEN USPAT; US-PGPL ("3809139") or ("3736969") or ("2722259") or ("2649884") or ("2138409") or ("1759339") or ("1705463")).PN. USPAT; US-PGPL US-5064176-\$ or US-5064176-\$ or US-5040775-\$ or US-5024461-\$ or US-5064176-\$ or US-5040775-\$ or US-3878598-\$ or US-3845860-\$ or US-3809139-\$ or US-373699-\$ or US-2722259-\$ or US-2649884-\$ or US-373699-\$ or US-2722259-\$ or US-2649884-\$ or US-2138409-\$ or US-1759339-\$ or US-1705463-\$).did. ("0036198").PN. US-1759339-\$ or US-1705463-\$).did. ("0036198").PN. US-176909/54.ipc.).CCLS. US-AT; US-PGPL EPO; JPC DERWEN US-4155.ccls. or 280/124.147.ccls.) and nut US-AT; US-PGPL EPO; JPC DERWEN US-AT; US-PGPL EPO; JPC DERWEN US-AT; US-PGPL EPO; JPC DERWEN US-AT; US-PGPL EPO; JPC DERWEN US-AT; US-PGPL EPO; JPC DERWEN US-AT; US-PGPL EPO; JPC DERWEN US-AT; US-PGPL EPO; JPC DERWEN US-AT; US-PGPL EPO; JPC DERWEN US-AT; US-PGPL EPO; JPC DERWEN US-AT; US-PGPL EPO; JPC DERWEN US-AT; US-PGPL EPO; JPC DERWEN US-AT; US-PGPL EPO; JPC DERWEN US-AT; US-PGPL EPO; JPC DERWEN US-PAT; US-PAT; US-PGPL EPO; JPC DERWEN US-PAT; US-PAT; US-PAT;				
- (("5088704") or ("5064176") or ("5040775") or ("5024461")).PN.  - (("5263694") or ("4425065") or ("3878598") or ("3845860") or ("3809139") or ("3736969") or ("2722259") or ("2649884") or ("2138409") or ("1759339") or ("1705463")).PN.  - (15) (US-508704-\$ or US-5064176-\$ or US-5040775-\$ or US-3878598-\$ or US-3845860-\$ or US-3809139-\$ or US-3736969-\$ or US-2722259-\$ or US-2649884-\$ or US-2138409-\$ or US-1759339-\$ or US-1705463-\$).did.  - (16) (509015/06.ipc. or f16f009/54.ipc.).CCLS (16) (280/124.155.ccls. or 280/124.147.ccls.) and nut  - (280/124.155.ccls. or 280/124.147.ccls.) not ((280/124.155.ccls. or 280/124.147.ccls.) not ((280/124.155.ccls. uS-PGFL EPO; JPC DERWEN US-PGFL EPO; JPC DE	-	10	kawada.in. and tadano.in.	
- 4 (("5088704") or ("5064176") or ("5040775") or ("5024461")).PN. USPAT; USPAT; US-PGPL USPAT; ("3809139") or ("3736969") or ("2722259") or ("2649884") or ("2138409") or ("1759339") or ("1705463")).PN.  - 15 (US-5088704-\$ or US-5064176-\$ or US-5040775-\$ or US-5024461-\$ or US-503694-\$ or US-3878598-\$ or US-3878598-\$ or US-3845860-\$ or US-38809139-\$ or US-3736969-\$ or US-2722259-\$ or US-2649884-\$ or US-2138409-\$ or US-2722259-\$ or US-2649884-\$ or US-2138409-\$ or US-1759339-\$ or US-1705463-\$).did.  - 0 ("0036198").PN. (b60g015/06.ipc. or f16f009/54.ipc.).CCLS. JPO JPO JPO B60g015/06.ipc. or f16f009/54.ipc.  - 106 (280/124.155.ccls. or 280/124.147.ccls.) and nut  - 107 (280/124.155.ccls. or 280/124.147.ccls.) and nut  - 108 (280/124.155.ccls. or 280/124.147.ccls.) not ((280/124.155.ccls. USPAT; US-PGPL EPO; JPC DERWEN USPAT; US-PGPL US-PAT; US-PGPL US-PAT; US				
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			US-PGPL
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			DERWEN
-	49	ikoma.in. and kayaba.asn.	USPAT;
1			US-PGPU
1			EPO; JPC
			DERWEN
-	6340	yoshiyuki.in.	USPAT;
1	[		US-PGPU
-	17	yoshiyuki.in. and kodama.in.	USPAT;
			US-PGPL
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			EPO; JPC
1			DERWEN
-	233	saenz.in.	USPAT;
1			US-PGPU
	1		EPO; JPC
			DERWEN
-	3	saenz.in. and cano.in.	USPAT;
			US-PGPU
			EPO; JPC
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-	346	(267/221).CCLS.	USPAT:
		1	US-PGPU
-	12	kawada.in. and tadano.in.	USPAT;
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Saarah



US006530587B2

# (12) United States Patent

Lawson et al.

(10) Patent No.: US 6

US 6,530,587 B2

(45) Date of Patent:

Mar. 11, 2003

# (54) WHEEL SUSPENSION SYSTEM HAVING AN INTEGRATED LINK, SPRING, AND ANTI-ROLL BAR

(75) Inventors: Robert Christian Lawson, Ann Arbor, MI (US); Frederick Mark Deadrick, Beverly Hills, MI (US)

(73) Assignee: Visteon Global Technologies, Inc., Dearborn, MI (US)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 70 days.

(21) Appl. No.: 09/870,251

(22) Filed: May 30, 2001

(65) Prior Publication Data

US 2002/0000703 A1 Jan. 3, 2002

# Related U.S. Application Data

(60) Provisional application No. 60/215,422, filed on Jun. 30, 2000.

(51)	Int. Cl.7		<b>B60G</b>	11/02
(31)	mu. Ci.	***************************************	DOOG	11/04

(52) U.S. Cl. ...... 280/124.17; 280/124.171; 267/52

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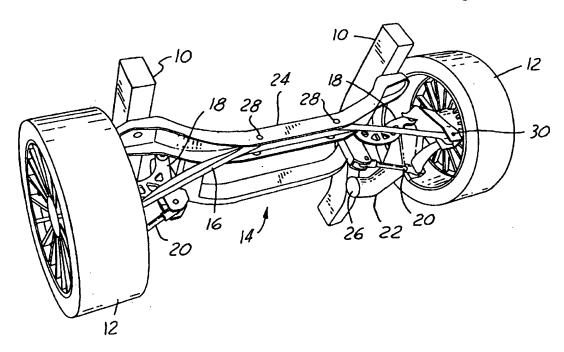
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Primary Examiner—Paul N. Dickson Assistant Examiner—Faye M. Fleming

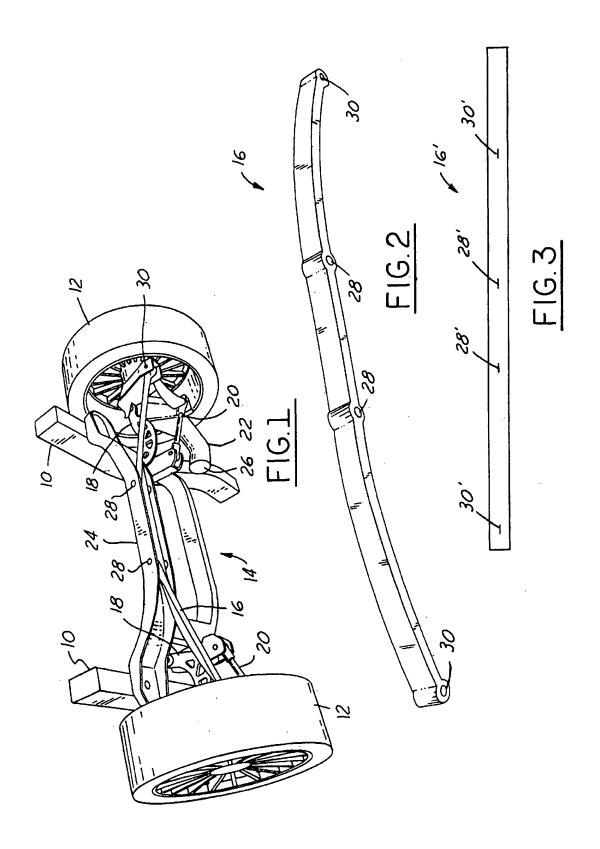
57) ABSTRACT

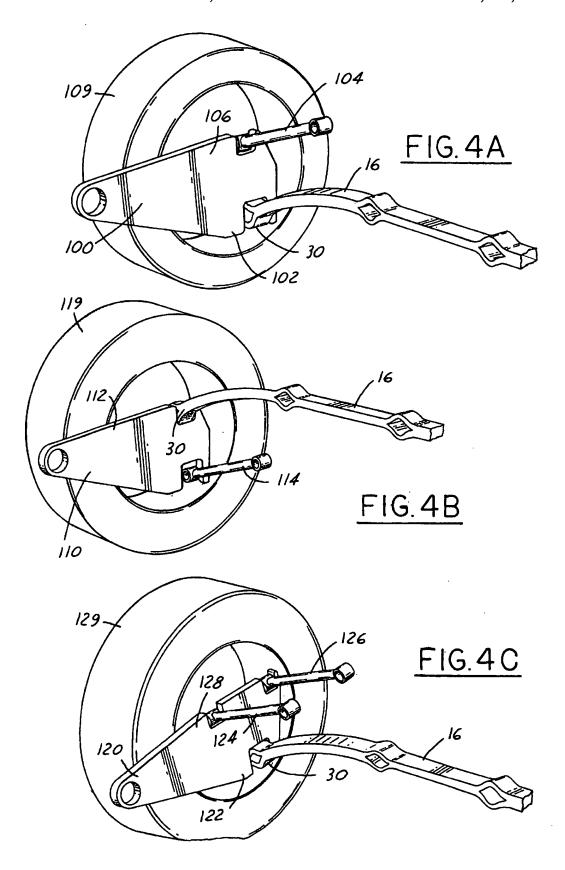
A rear wheel suspension system replaces the lower control arms, coil springs, and anti-roll bar assembly in the prior art with a simple composite beam. By carefully designing the shape of the beam, the material system and the pivot locations, the ride and roll rates and camber and toe characteristics of the original prior art suspension system can be preserved.

## 15 Claims, 4 Drawing Sheets



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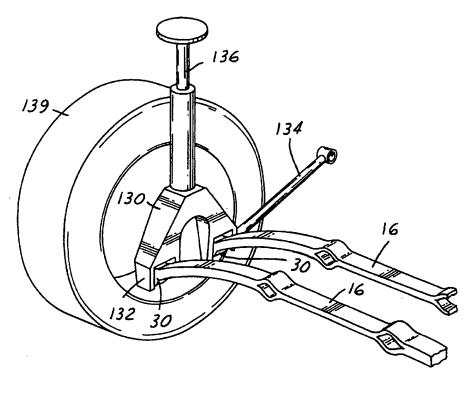
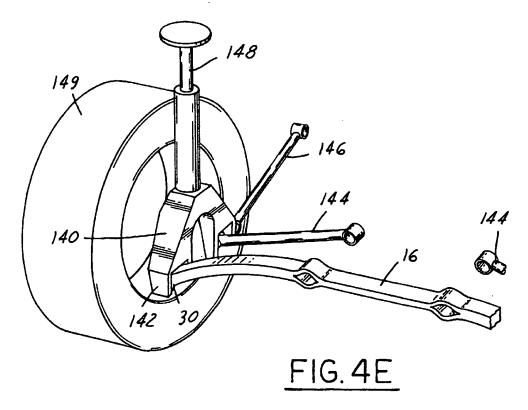
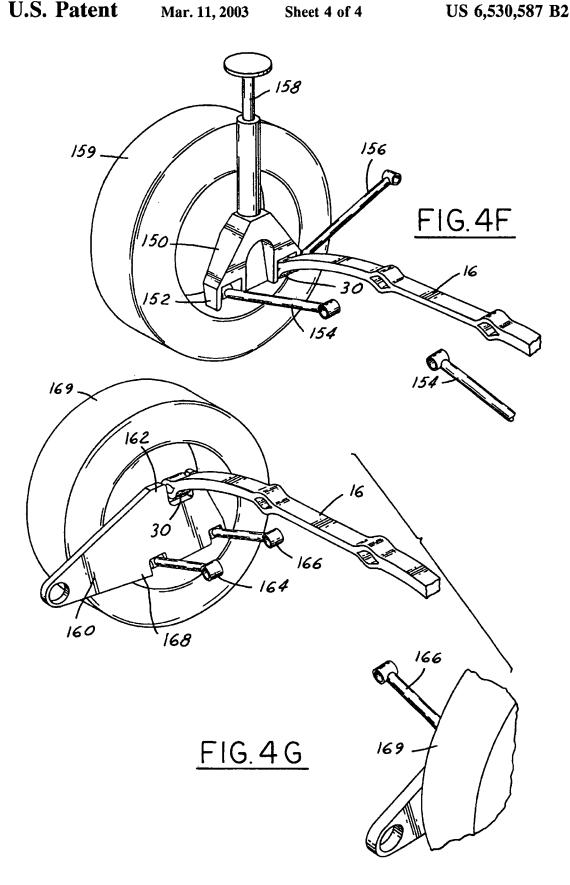


FIG.4D



12/20/2003, EAST Version: 1.4.1



# WHEEL SUSPENSION SYSTEM HAVING AN INTEGRATED LINK, SPRING, AND ANTI-ROLL BAR

# CROSS REFERENCE TO RELATED APPLICATIONS

The present invention claims priority from co-pending U.S. Provisional Application Serial No. 60/215,422, filed Jun. 30, 2000 and entitled "Method of Manufacturing Cross-Car Leaf Spring and Article Produced Thereby."

#### TECHNICAL FIELD

The present invention relates generally to wheel suspension systems for motor vehicles, and more particularly, to a 15 rear wheel suspension system having an integrated link, spring, and anti-roll bar.

#### BACKGROUND ART

A suspension system on an automobile works with the tires, frame or unit body, wheels, wheel bearings, brake system, and steering system to provide a safe and comfortable mode of transportation. A suspension system has several important functions, including supporting the various components of an automobile, allowing the tires to move up and down to provide a comfortable ride, allowing for rapid cornering without extreme body roll, keeping the tires on the road surface, preventing excessive body squat when accelerating, preventing excessive body dive when braking, allowing the front wheels to turn side-to-side for steering, and, in combination with the steering system, keeping the wheels in correct alignment.

These suspension systems use front and rear springs to suspend a vehicle's frame, body or unitized body, engine, and powertrain above the wheels. These relatively heavy assemblies constitute what is known as "sprung" weight. The "unsprung" weight, on the other hand, includes wheels and tires, brake assemblies, and other structural members not supported by the springs. Unfortunately, high "unsprung" weight may result in adverse vehicle characteristics. Reduction of "unsprung" weight, therefore, is desirable.

Many front and rear suspension systems incorporate compression type coil springs. Some front and rear coil springs are mounted between a lower control arm and spring housing or seat in the vehicle frame or body. Coil springs are made of steel or steel alloy and may have evenly or variably spaced coils to provide adequate durability and vehicle stability under all intended load conditions. Unfortunately, compression type coil springs are typically heavy and may require significant packaging space within the vehicle.

When coil springs are used in either a front or rear suspension, three or four linkages are typically placed between the wheel axles and the frame to carry driving and braking torque. These linkages support driving and braking torque, the vertical load due to road loads, and cornering (lateral) loads. The lower control arms pivot in the frame members and sometimes support the rear coil springs to provide for up and down movement of the axle and wheel assembly. Unfortunately, these linkages increase the amount of "unsprung" weight, while increasing overall part count and complexity.

In addition, an anti-roll bar is usually attached from the rear suspension lower control arm to the frame side rail to 65 hold the rear axle housing in proper alignment with the frame and to prevent side sway (roll motion) of the body.

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Unfortunately, anti-roll bars are typically heavy and require significant packaging within the vehicle. In addition, anti-roll bars increase the overall part count and complexity of suspension systems.

The disadvantages associated with these conventional rear suspension techniques have made it apparent that a new technique for rear suspension is needed. The new technique should integrate multiple automotive suspension functions into one integral unit. Additionally, the new technique should reduce part count and weight while potentially improving noise vibration and harshness (NVH) and reducing complexity. The present invention is directed to these ends.

## SUMMARY OF THE INVENTION

It is, therefore, an object of the invention to provide an improved and reliable rear wheel suspension system having an integrated link, spring, and anti-roll bar. Another object of the invention is to reduce part count and weight while improving NVH and reducing complexity and cost.

In accordance with the objects of this invention, a rear wheel suspension system having an integrated link, spring, and anti-roll bar is provided. In one embodiment of the invention, a rear wheel suspension system replaces the lower control arms, coil springs, and anti-roll bar assembly in the prior art with a simple composite beam. By designing the shape of the beam, the material system and the pivot locations, the ride and roll rates and camber and toe characteristics of the original prior art suspension system can be preserved.

The present invention thus achieves an improved rear wheel suspension system having an integrated link, spring, and anti-roll bar. The present invention is advantageous in that it integrates multiple automotive suspension functions into one unit.

Additional advantages and features of the present invention will become apparent from the description that follows, and may be realized by members of the instrumentalities and combinations particularly pointed out in the appended claims, taken in conjunction with the accompanying drawings.

# BRIEF DESCRIPTION OF THE DRAWINGS

In order that the invention may be well understood, there will now be described some embodiments thereof, given by way of example, reference being made to the accompanying drawings, in which:

FIG. 1 is an illustration of a rear wheel suspension system having an integrated link, spring, and anti-roll bar in accordance with one embodiment of the present invention;

FIG. 2 is an illustration of a composite beam in accordance with one embodiment of the present invention;

FIG. 3 is a cross section of a 3D woven preform part for a composite beam in accordance with a preferred embodiment of the present invention; and

FIGS. 4A-G are illustrations of alternative preferred ways of locating the composite beam on a trailing arm within a rear wheel suspension system.

# BEST MODES FOR CARRYING OUT THE INVENTION

In the following figures, the same reference numerals will be used to identify identical components in the various views. The present invention is illustrated with respect to a

rear wheel suspension system having an integrated link, spring, and anti-roll bar, particularly suited for the automotive field. However, the present invention is applicable to various other uses that may require rear wheel suspension systems.

Referring to FIG. 1, a rear wheel suspension system 14 having an integrated link, spring, and anti-roll bar in accordance with one embodiment of the present invention is illustrated. A motor vehicle chassis 10 (or unitized body and chassis) is supported on left and right road wheels 12 by a wheel suspension system 14. The wheel suspension system 14 includes a composite beam 16, a pair of upper control arms 18, and a pair of lower toe links 20.

The composite beam 16 replaces the lower control arms, coil springs, and anti-roll bar assembly in the prior art rear wheel suspension system. The composite beam 16 is preferably composed of a fiber-reinforced thermoset or thermoplastic polymer laminate material. Preferably, the polymer used in the composite laminate layers is an epoxy resin. The method for making the composite beam 16 is described 20 below in FIG. 3.

Each upper control arm 18 and lower toe link 20 connects a flexible trailing arm 22, or knuckle, to the motor vehicle chassis 10 through a chassis cross-member 24. Members are provided to pivotally connect the forward end 26 of each trailing arm 22 to the chassis 10. Additional members are provided to pivotally connect the inner ends of each upper control arm 18 and lower toe link 20 to the chassis cross-member 24 and their outer ends to a respective trailing arm 22.

As best seen in FIG. 2, inner attachment members 28 are provided to pivotally connect the composite beam 16 to the chassis cross-member 24. Also, outer attachment members 30 are provided at each end of composite beam 16 to pivotally connect the chassis cross-member 24 to a respective trailing arm 22.

Referring to FIG. 3, a cross section of a 3D woven preform part 16' for a composite beam 16 in accordance with one embodiment of the present invention is illustrated. In 40 this process, multiple spools of fiber (glass and/or carbon) feed fiber into a weaving machine that loops the fiber across the width and through the thickness, with a majority of the fibers running along the length of the composite beam preform. A curable resin, preferably an epoxy resin, is added to the weaving to bind the fibers into a preform. The initial preform would be approximately 1.5 m wide and may be manufactured using a 3D textile weaving process. Approximately 50 mm of the initial preform would be cut off for each part 16'. Sacrificial inserts would be placed into the 50 preform slits, corresponding to an outer pivot 30' and inner pivot 28', thereby expanding them into holes that are used to form attachment members 30 and 28, respectively. This preform 16' could then be placed in a mold and consolidated with resin using a resin transfer molding (RTM) or vacuumassisted resin transfer molding (VARTM) process to form the finished composite beam 16.

In an alternative fabrication method, the initial preform 16' could be cut very wide (500–1000 mm wide. After the wide piece is molded and cured, the preform is cut into 50 60 mm pieces using a saw or waterjet or similar type device. This method may be preferable in that it is easier to cut the preform 16' after curing and because it is more efficient to load one large preform into a mold as compared with multiple smaller preforms into multiple molds.

The composite beam 16 may also be made using other composite manufacturing techniques. These techniques may

include the use of fiber pre-impregnated with resin, dry fibers consolidated using either the RTM or VARTM process, filament winding, textile braiding, or other composite manufacturing techniques known in the art.

The present invention allows the trailing arm 22 to locate the wheel axis fore/aft and react to braking torque, while the three lateral links (provided by composite beam 16, upper control arm 18, and lower toe link 20) provide camber and toe control. Due to the present suspension design, the wheel axis moves along an arc as viewed in the side view. The outer attachment members 30 on the composite beam 16 must also follow an arc. The composite beam 16 must flex both vertically and fore/aft. The outer attachment member 30 is free to flex in the Y direction, and in doing so it controls the toe along with the upper control arm 18. To reduce stresses and forces in the member 16 due to the fore/aft bending of the member 16 as the outer attachment member 30 follows the arc, the concept of using a composite beam 16 with a cross section whose bending axis is angled in the XZ plane may be used. This results in a composite beam 16 that travels fore/aft as well as vertically when loaded with only a vertical load at the outer attachment member 30. The composite beam 16 may be designed to have a trapezoidal cross section to lower stresses.

By carefully designing the shape of the composite beam 16, the material system and the pivot locations 28, the ride and roll rates and camber and toe characteristics of the rear wheel suspension system 14 can be changed to achieve desired characteristics. For example, by varying the bending stiffness at various points along the composite beam 16, the ride and roll characteristics of the rear wheel suspension system 14 may be altered.

While the composite beam 16 present invention is preferably coupled to the trailing arm 22 as in FIG. 1, there are many other ways of locating the composite beam 16 onto the trailing arm 22. Some of these preferred ways are depicted below in FIGS. 4A-4G.

The descriptions below in FIGS. 4A-4G refer to two different types of trailing arms; semi-rigid and flexible. In flexible trailing arms, the region of the trailing arm connecting the lateral links, composite beam 16, and the axle are fairly rigid. Meanwhile the forward portion of the trailing arm is relatively flexible, having a thin (Y direction) yet tall (Z direction) cross section. This yields a suspension system where toe and camber are controlled by the lateral links and cross car spring(s), while the forward portion of the trailing arm reacts the braking torque and provides fore/aft location. This design allows the suspension to be better tuned to both improve handling and reduce NVH.

Semi-rigid trailing arms, on the other hand, play an integral role in controlling toe in the suspension, in addition to the functions it provides as described above with regards to flexible trailing arms. Suspension topologies including a "semi-rigid" trailing arm typically require one fewer locating members (either composite beam 16 or lateral link) per side.

Referring now to FIG. 4A, the outer attachment members 30 of the composite beam 16 are each coupled to a respective lower portion 102 of a semi-rigid trailing arm 100. An upper control arm 104 is also shown coupled to an upper portion 106 of the semi-rigid trailing arm 100. Each trailing arm 100 is used for rotatably mounting a road wheel 109.

Referring now to FIG. 4B, the outer attachment members 30 of the composite beam 16 are coupled to a respective upper portion 112 of a semi-rigid trailing arm 110. A lower toe link 114 is also coupled to a lower portion 116 of the

semi-rigid trailing arm 110. Each trailing arm 110 is used for rotatably mounting a road wheel 119.

Referring now to FIG. 4C, the outer attachment members 30 of the composite beam 16 are coupled to a lower portion 122 of a flexible trailing arm 120. A pair of upper control arms 124, 126 are also shown coupled to an upper portion 128 of the semi-rigid trailing arm 120. Each trailing arm 120 is used for rotatably mounting a road wheel 129.

Referring now to FIG. 4D, the outer attachment members 10 30 of a pair of composite beams 16 are each coupled to a respective lower portion 132 of a semi-rigid trailing arm 130. Also coupled to the semi-rigid trailing arm 130 is a fore-aft link 134 and a damper and strut 136. Each trailing arm 130 is used for rotatably mounting a road wheel 139. 15

Referring now to FIG. 4E, the outer attachment members 30 of a composite beam 16 are coupled to a respective lower portion 142 of a semi-rigid trailing arm 140. A lower toe link 144 is also coupled to the lower portion 142. Also coupled to the semi-rigid trailing arm 140 is a fore-aft link 146 and a damper and strut 148. In this embodiment, the fore-aft link 146 is located is close proximity to the lower toe link 144. Each trailing arm 140 is used for rotatably mounting a road wheel 149.

Referring now to FIG. 4F, the outer attachment members 30 of a composite beam 16 are coupled to a respective lower portion 152 of a semi-rigid trailing arm 150. A lower toe link 154 is also coupled to the lower portion 152. Also coupled to the semi-rigid trailing arm 150 is a fore-aft link 156 and 30 a damper and strut 158. In this embodiment, the fore-aft link 156 is located is close proximity to the composite beam 16. Each trailing arm 150 is used for rotatably mounting a road wheel 159.

Referring now to FIG. 4G, the outer attachment members 30 of the composite beam are attached to a respective upper portion 162 of a semi-rigid trailing arm 160. A pair of lower toe links 164, 166 are also coupled to a lower portion 168 of the semi-rigid trailing arm 160. Each trailing arm 160 is used for rotatably mounting a road wheel 169.

While not shown in FIGS. 4A-4G, each trailing arm 102, 110, 120, 160 or trailing arm knuckle 130, 140, 150 is attached to the vehicle chassis at its forward end in a manner similarly described in FIG. 1, wherein the forward end 26 of 45 the trailing arm 22 is coupled to the vehicle chassis. Also, each fore-aft link 134, 146, 156 is attached to the vehicle body or frame. Further, each upper control arm 104, 124, 126 is mounted to a vehicle chassis cross member in a manner similar to the mounting of the upper control arm 18 50 in FIG. 1. Finally, each lower toe link 114, 144, 154, 166 is coupled to a chassis cross member in a manner similar to mounting the lower toe link 20 to the chassis cross-member 24 in FIG. 1.

The present invention thus achieves an improved and reliable rear wheel suspension system having an integrated link, spring, and anti-roll bar by using a composite beam 16. In this way, the present invention integrates multiple automotive suspension functions into one integral unit.

It is to be understood that the preceding description of the preferred embodiment is merely illustrative of some of the many specific embodiments that represent applications of the principles of the present invention. Clearly, numerous and other arrangements would be evident to those skilled in 65 the art without departing from the scope of the invention as defined by the following claims.

What is claimed is:

- 1. A rear wheel suspension for a vehicle comprising:
- a chassis:
- a pair of trailing arms for rotatably mounting a pair of road wheels;
- a chassis cross-member coupled to said chassis;
- a composite beam having outer attachment members and inner attachment members, said outer attachment members rotatably coupled to each of said pair of trailing arms and said inner attachment members rotatably coupled to said chassis cross-member; and
- a pair of upper control arms, each of said upper control arms having an inner control arm end and an outer control arm end, wherein said inner control arm ends are rotatably coupled to said chassis cross-member and wherein said outer control arm ends are each rotatably coupled to a respective one of said pair of trailing arms.
- 2. The rear wheel suspension for a vehicle as recited in claim 1, wherein said chassis is a unitized body.
- 3. The rear wheel suspension for a vehicle as recited in claim 1, wherein said chassis is a vehicle frame.
- 4. The rear wheel suspension for a vehicle as recited in claim 1, further comprising a pair of lower toe links, each of said lower toe links having an inner lower link arm end and an outer toe link arm end, wherein each of said inner toe link arm ends are rotatably coupled to said chassis cross-member and wherein each of said outer toe link arm ends are rotatably coupled to a respective one of said pair of trailing arms.
- 5. The rear wheel suspension for a vehicle as recited in claim 1, wherein said composite beam has a rectangular cross section.
- 6. The rear wheel suspension for a vehicle as recited in claim 1, wherein said composite beam has a cross section whose bending axis is angled in the XZ plane.
- 7. The rear wheel suspension for a vehicle as recited in claim 1, wherein said composite beam has a trapezoidal cross section.
- 8. The rear wheel suspension for a vehicle as recited in claim 1, wherein a location of said outer attachment members and inner attachment members on said composite beam are adjusted such that a bending trajectory of said composite beam approximately matches a target arc.
  - 9. A rear wheel suspension for a vehicle comprising: a chassis:
  - a pair of trailing arms for rotatably mounting a pair of road wheels;
  - a chassis cross-member coupled to said chassis; and
  - a composite beam having outer attachment members and inner attachment members, said outer attachment members rotatably coupled to each of said pair of trailing arms and said inner attachment members rotatably coupled to said chassis cross-member; and
  - a pair of lower toe links, each of said lower toe links having an inner lower link arm end and an outer toe link arm end, wherein each of said inner toe link arm ends are rotatably coupled to said chassis cross-member and wherein each of said outer toe link arm ends are rotatably coupled to a respective one of said pair of trailing arms.

- 10. The rear wheel suspension for a vehicle as recited in claim 9, wherein said chassis is a unitized body.
- 11. The rear wheel suspension for a vehicle as recited in claim 9, wherein said chassis is a vehicle frame.
- 12. The rear wheel suspension for a vehicle as recited in 5 claim 9, wherein said composite beam has a rectangular cross section.
- 13. The rear wheel suspension for a vehicle as recited in claim 9 wherein said composite beam has a cross section whose bending axis is angled in the XZ plane.

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- 14. The rear wheel suspension for a vehicle as recited in claim 9, wherein said composite beam has a trapezoidal cross section.
- 15. The rear wheel suspension for a vehicle as recited in 9, wherein a location of said outer attachment members and inner attachment members on said composite beam are adjusted such that a bending trajectory of said composite beam approximately matches a target arc.

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